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FORM PTO-1390 (REV. 9-2001) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: 0074-456205GWW

U.S. APPLICATION NO. (If known, see 37 CFR 1.5): 10/019598

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/NZ00/00118	(03.07.00) 03 July 2000	(02.07.99) 02 July 1999

TITLE OF INVENTION: APPARATUS AND METHOD FOR GAS SENSING

APPLICANT(S) FOR DO/EO/US: WILSON, Andrew

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [ ] This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [ ] The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is attached hereto (required only if not communicated by the International Bureau).
   b. [X] has been communicated by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [ ] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. [ ] is attached hereto.
   b. [ ] has been previously submitted under 35 U.S.C. 154(d)(4).
7. [ ] Amendments to the claims of the International Aplication under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   b. [ ] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. [ ] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] An English lanugage translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [X] A FIRST preliminary amendment.
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [ ] A substitute specification.
16. [ ] A change of power of attorney and/or address letter.
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. [ ] A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. [X] Other items or information:
    - Transmittal of Letter to the United States Designated/Elected Office (DO/EO/US) by Express Mail (Label No. EL680720067US);
    - Total Fees: $520.00 check (basic national fee-small entity).

U.S. APPLICATION NO (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
10/019598	PCT/NZ00/00118	0074-456205GWW

21. [X] The following fees are submitted:	CALCULATIONS PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):	
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**	1040.00
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$740.00**	
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**	
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**	
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 1040.00
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	8 - 20 =	0	x **$18.00**	$ 0.00
Independent claims	2 - 3 =	0	x **$84.00**	$ 0.00
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$280.00**	$
TOTAL OF ABOVE CALCULATIONS =				$ 1040.00
[X] Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2. +				$ 520.00
SUBTOTAL =				$ 520.00
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				$
TOTAL NATIONAL FEE =				$ 520.00
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$
TOTAL FEES ENCLOSED =				$ 520.00
				Amount to be refunded: $
				charged: $

a. [X] A check in the amount of $ 520.00 to cover the above fees is enclosed.

b. [ ] Please charge my Deposit Account No. _____ in the amount of $ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 04-1406 A duplicate copy of this sheet is enclosed.

d. [ ] Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

CUSTOMER NUMBER 000110 or
DANN DORFMAN HERRELL AND SKILLMAN, P.C.
1601 Market Street, Suite 720
Philadelphia, PA 19103-2307
USA

Vincent T. Pace
SIGNATURE

Vincent T. Pace
NAME

31,049
REGISTRATION NUMBER

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of	: **(Docket 0074-456205GWW)**
WILSON, Andrew	:
U.S. Appln. No. (not assigned yet) International Appln. No. PCT/NZ00/00118	:
International Filing Date July 3, 2000	:
For: **APPARATUS AND METHOD FOR GAS SENSING**	:

PRELIMINARY AMENDMENT

As a preliminary matter, please amend the above-identified application as follows:

In the Claims:

Amend Claims 3, 4, 7, and 8 to read as follows:

3.(Amended) An apparatus according to claim 2 further comprising means between the light source and the optical fibre arranged to split the returned light from the transmitted light and direct the returned light to the photodetector.

4.(Amended) An apparatus according to claim 3 wherein the light source and photodetector are positioned remotely to the gas cell or zone.

7.(Amended) A method according to claim 6 further comprising splitting, between the light source and the optical fibre, the returned light from the transmitted light and directing the returned light to the photodetector.

8.(Amended) A method according to claim 7 wherein the light source and photodetector are positioned remotely to the gas cell or zone.

Cancel claim 9 and 10.

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REMARKS

No new matter has been introduced into this application by reason of the claim amendments presented herewith. The only purpose of this Preliminary Amendment is to correct the form of Claims 3, 4, 7, and 8 to avoid the prohibition in 37 CFR 1.75(c) against a multiple dependent claim serving as a basis for another multiple dependent claim. There is no intention to limit the scope of those claims either expressed or implied. A marked-up copy of the amended claims is attached hereto pursuant to 37 CFR 1.121(c)(3).

It is respectfully requested that the above amendments be entered prior to the first official action on this application.

Respectfully submitted,

DANN, DORFMAN, HERRELL AND SKILLMAN
A Professional Corporation
Attorneys for Applicant(a)

By Vincent T. Pace

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U.S. Appln. No. not assigned yet
International Appln. No. PCT/NZ00/00118
Docket No. 0074-456205GWW

APPENDIX A

Claim Amendments

3.(Amended) An apparatus according to [either one of claims 1 and 2] claim 2 further comprising means between the light source and the optical fibre arranged to split the returned light from the transmitted light and direct the returned light to the photodetector.

4.(Amended) An apparatus according to [any one of claims 1 to 3] claim 3 wherein the light source and photodetector are positioned remotely to the gas cell or zone.

7.(Amended) A method according to [either one of claims 5 and 6] claim 6 further comprising splitting, between the light source and the optical fibre, the returned light from the transmitted light and directing the returned light to the photodetector.

8.(Amended) A method according to [any one of claims 5 to 7] claim 7 wherein the light source and photodetector are positioned remotely to the gas cell or zone.

APPARATUS AND METHOD FOR GAS SENSING

FIELD OF INVENTION

The invention relates to an optical fibre delivery system for apparatus and method for sensing properties of a gas such as concentration or temperature by reference to the attenuation of light passing through the gas (trace gas sensing).

SUMMARY OF INVENTION

In broad terms in one aspect the invention comprises apparatus for remote gas sensing comprising a photodetector and a gas cell containing a gas or zone through which the gas passes and through which light from a light source passes and is reflected back to the photodetector, wherein the light source and photodetector, and the gas cell, are connected by a single polarisation preserving optical fibre through which light from the source passes to the gas cell, with light reflected back from the cell passing back through the optical fibre with a different polarisation to the transmitted light.

In one form the apparatus of the invention more specifically comprises a light source, a gas cell or zone, a photodetector to receive light reflected back from the gas cell, a single polarisation preserving optical fibre connecting the light source and photodetector to the gas cell, means to polarise return light exiting the gas so that it re-enters the optical fibre polarised orthogonal to the transmitted light, and means at the other end of the optical fibre to split the return light from the transmitted light and direct the return light to the photodetector.

In broad terms in another aspect the invention comprises a method for remote gas sensing utilising a photodetector and a gas cell or zone containing the gas or through which the gas passes and through which light from a source passes and is reflected back to the photodetector, including passing light from the source to the gas cell and back to the photodetector via a single polarisation preserving optical fibre such that the return light passes through the optical fibre with a different polarisation to that of the transmitted light.

In the apparatus and method of the invention the light source and photodetector are connected to the gas cell or zone via an arrangement including a polarisation preserving optical fibre which carries the transmitted and reflected light with different polarisations, which enables the photodetector and gas cell or zone to be remotely positioned from one another. The photodetector and associated electronics do not need to be positioned close to the gas cell or zone. The use of different polarisation for transmitted and reflected light eliminates unwanted optical interference, and enables separation of reflected from transmitted light for optical detection.

BRIEF DESCRIPTION OF THE DRAWING

The accompanying drawing schematically illustrates one preferred arrangement of gas sensing apparatus, by way of example.

DETAILED DESCRIPTION OF PREFERRED FORM

Light from a source such as a laser passes through a polarising beam splitter 1 which is oriented to linearly polarise the light parallel to one of the two polarisation maintaining axis of a polarisation preserving single-mode optical fibre 2. The light is launched into the polarisation preserving fibre by a lens 3, and propagates through the optical fibre maintaining its polarisation state.

Upon exiting the fibre, the light is collimated by a second lens 4, and propagates through a gas sample region or cell 5, in a double pass configuration using a quarter-wave retarder 6 and retro-reflecting mirror 7. Some of the light is absorbed by the gas as it propagates through the gas ample, and this is used to determine properties of the sample, such as concentration and temperature.

Quarter-wave retarder 6 is oriented to change the polarisation state of the transmitted light from linear to pure circular. After retro-reflection by the mirror 7, the return light then passes back through the quarter-wave retarder 6, which changes the polarisation state of the light from circular back to linear, but with an orientation perpendicular to that of the forward propagating (transmitted) light. The mirror 7 is aligned so that the reflected light is launched back into the fibre, but because it is linearly polarised perpendicular to the forward propagating light, the

reflected light is polarised parallel to the other polarisation preserving axis of the optical fibre. This means that the forward and retro-reflected light propagates simultaneously through the optical fibre, but they have orthogonal linear polarisation states.

Upon exiting the fibre, the retro-reflected light is separated from the forward propagating light by the polarising beam splitter 1, and directed to the photodetector where its intensity is measured.

The preferred form illustrated is described by way of example. Alternative arrangements utilised in the concept of the invention are possible. For example in an alternative arrangement light exiting the optical fibre may be allowed to diverge by removing the collimating lens 4, and then retro-reflected using a spherical mirror placed a small distance equal to the radius of curvature of the mirror. In addition, separate optical components may be replaced by thin film or optical fibre based elements.

The gas sample region or cell 5 may be positioned in a hostile environment (for example hot or toxic), a cramped environment (for example within a compact machine), or a very distant location (for example on top of a smoke stack).

The foregoing describes the invention including a preferred form thereof. Alterations and modifications as will be obvious to those skilled in the art are intended to be incorporated within the scope hereof as defined in the accompanying claims.

CLAIMS

1. An apparatus for remote gas sensing comprising a light source, a photodetector, a gas cell containing gas or a zone through which the gas passes and through which light from the light source passes and is reflected back to the photodetector, wherein the light source, photodetector and gas cell are connected by a single polarisation preserving optical fibre through which light from the light source passes to the gas cell, which light reflected back from the cell passes back through the optical fibre with a different polarisation to that to the light transmitted by the light source.

2. An apparatus according to claim 1 further comprising means to polarise the returned light exiting the gas so that it re-enters the optical fibre polarised orthogonal to the transmitted light.

3. An apparatus according to either one of claims 1 and 2 further comprising means between the light source and the optical fibre arranged to split the returned light from the transmitted light and direct the returned light to the photodetector.

4. An apparatus according to any one of claims 1 to 3 wherein the light source and photodetector are positioned remotely to the gas cell or zone.

5. A method for remote gas sensing utilising a light source, a photodetector and a gas cell or zone containing gas or through which gas passes and through which light from the light source passes and is reflected back to the photodetector, including passing light from the source to the gas cell and back to the photodetector via a single polarisation preserving optical fibre such that the return light passes through the optical fibre with a different polarisation to that of the transmitted light.

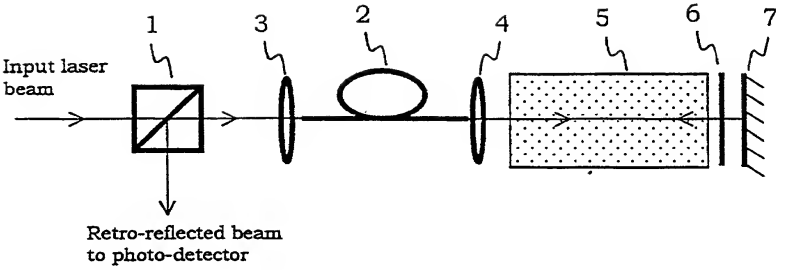
6. A method according to claim 5 further comprising polarising the returned light exiting the gas so that it re-enters the optical fibre polarised orthogonal to the transmitted light.

7. A method according to either one of claims 5 and 6 further comprising splitting, between the light source and the optical fibre, the returned light from the transmitted light and directing the returned light to the photodetector.

8. A method according to any one of claims 5 to 7 wherein the light source and photodetector are positioned remotely to the gas cell or zone.

9. An apparatus for remote gas sensing, substantially as herein described with reference to the accompanying drawing.

10. A method for remote gas sensing, substantially as herein described with reference to the accompany drawing.



0074-4562QSGWW

DECLARATION, POWER OF ATTORNEY AND POWER TO INSPECT

As a below named inventor, I hereby declare:

that my residence, post office address and citizenship are as stated below next to my name;

that I believe I am the original, first and sole inventor (if only one name is listed below) or an original and first inventor (if plural inventors are named below) of the subject matter of this application which is entitled: **APPARATUS AND METHOD FOR GAS SENSING**

the specification of which [check one(s) applicable]
_X_ was filed __03 July 2000__ as PCT International/~~XXXXXXXXXXXXXXXXXXXXXX~~ __PCT/NZ00/00118__
___ and was amended by Amendment filed _____ (if applicable); [or];
___ is attached to this Declaration, Power of Attorney and Power to Inspect;

that I have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment referred to above; and

that I acknowledge my duty to disclose information which is material to the examination of this application in accordance with Rule 56(a) [37CFR§1.56(a)].

~~CLAIM~~ **UNDER 35 U.S.C. §119:** I hereby claim foreign priority benefits under 35 USC §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application of which priority is claimed:

Prior Foreign Application(s)		Filing Date	Priority Claimed
Application No.	Country	Day-Mo-Year	Yes - No
336552	New Zealand	02 - 07 - 99	Yes

POWER OF ATTORNEY: As inventor, I hereby appoint the practitioners associated with **Customer No. ~~000110 as~~ my** attorneys or agents with full power of substitution to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: **Vincent T. Pace, Reg. No. 31,049 and Patrick J. Hagan, Reg. No. 27,643**

POWER TO INSPECT: I hereby give **DANN, DORFMAN, HERRELL AND SKILLMAN, P.C.** of Philadelphia, PA or its duly accredited representatives power to inspect and obtain copies of the papers on file relating to this application.

SEND CORRESPONDENCE TO: CUSTOMER NUMBER 000110

DIRECT INQUIRIES TO: Vincent T. Pace
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Fax: 215-563-4044

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

SOLE OR FIRST JOINT INVENTOR

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Signature _____

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